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Experimental Investigation on Use of Pond Ash and Quarry Dust as Partial Replacement of Cement & Fully Replacement of Fine Aggregate in Cement Concrete

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***Abstract* - Pulverized Coal Combustion (PCC) dry pond ash is a by-product of coal combustion that originates from the burning of pulverized coal to produce electricity. Because of the increasing costs associated with the disposal of pond ash and the environmental regulations in place, a significant need exists to develop alternate methods for profitable and environmentally safe uses of this waste material. Because of this Pond ash is used as a partial replacement for cement in concrete mix which may improve the quality of concrete structure in terms of strength and durability.**

River sand is most commonly used as fine aggregate in the production of concrete poses the problem of acute shortage in many areas and the continued use has started posing serious problems with respect to its availability, cost and environmental impact. As environmental transportation and other constraints make the availability and use of river sand less attractive, a substitute or replacement product for concrete industry needs to be found. Hence Natural Sand is fully replaced by Quarry Rock Dust. Hence in this project, an attempt has been made to study the strength of the concrete made of Pond ash and Quarry Rock Dust.

Keywords* - *Pond ash, Quarry Rock Dust., Natural Sand,.

1. INTRODUCTIN

Use of waste and by-products in concrete will lead to green environment and such concrete can be called as "Green Concrete". There are various types of waste materials that can be considered for the usage in concrete. The most commonly used waste materials to replace sand and cement in concrete are Fly Ash, Rice Husk Ash, Blast Furnace Slag, Red Mud and Phosphor, Gypsum, Silica Fume, Fumed Silica, Crushed Glass, Eggshells. The waste products commonly used to replace coarse aggregate in concrete are Palm Oil Shell Aggregate for Lightweight Aggregate Concrete, Crushed Ceramic, Glass, Waste Wood, crushed concrete aggregate. Here we are using Pond Ash and Quarry Dust as replacements for cement and fine aggregate respectively in concrete. The current annual production of coal ash worldwide is estimated around 600 million tones. The coal based power plant generates a huge amount of ash. In India, it is about 170 mt for the year 2011-12 and is expected to be above 600mt for the year 2031-32. The generated ash contains about 20 percent Pond ash and 80 percent fly ash of the total ash generated. Fly ash is been recycled as an alternative to cement while pond ash is being disposed off. The disposal of large quantity of pond ash requires huge area of land, water and energy. If not managed well becomes a health hazard and damages the environment. The disposal of fly ash will be a big challenge to environment, especially when the quantum increases from the present level. Hence worldwide research work was focused to find alternative use of this waste material and its use in concrete industry is one of the effective methods of utilization. So recycling pond ash might be able to sort out the above mentioned issues.

Quarry Rock Dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm. Usually, Quarry Rock Dust is used in large scale in the highways as a surface finishing material and also used for manufacturing of hollow blocks and lightweight concrete prefabricated Elements. Use of Quarry Rock Dust as a fine aggregate in concrete draws serious attention of researchers and investigators.

This paper addresses the issues pertaining to the change in engineering properties of the concrete containing Pond Ash and Quarry Dust.

Pond Ash

Infrastructural needs are growing very fast in worldwide and has led to the demand of large amount of materials for constructions. Lot of research work is being carried out to use the alternative materials for constructions satisfying strength and performance criteria of structures. Substitution of raw materials / constituents with alternative is an important eco efficiency driver and is need of the hour. Pond Ash, is one such alternative material which can be conveniently used to replace the natural material at an intermixing level which is limited by technical and other concern, in structural concrete, geotechnical and highway constructions, encouraging the use of huge amount of coal ash generated from TPP -Thermal Power Plants.

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When pulverized coal is burnt in a dry, bottom boiler, about 80 percent of the unburnt material or ash is entrained in the flue gas and is captured and recovered as fly ash. The remaining 20 percent of the ash is dry bottom ash, a dark gray, granular, porous, material that is collected in a water-filled hopper at the bottom of the furnace . The lagoon bottom ash is usually combined with fly ash. This blended fly ash and bottom ash are referred to as pond ash percent of all coal ash is handled wet and disposed of as pond ash . This wet process of disposal demands for thousands of hectares of land including agricultural and forest land. Though there is considerable increase (from 3%in 1993 to30% in 2010) in the use of coal ash, utilization fraction\rate needs to be increased in order to reduce grave environmental consequences. One of the important reason being caution of World Bank to India that by 2015disposal of coal ash would require 1000 square km. or one meter square of land per person.

Fig.1. Storage Lagoons - Pond Ash

Fig.2 Pond Ash

Quarry dust

Quarry dust is a waste obtained during quarrying process. It has very recently gained good attention to be used as an effective filler material instead of fine aggregate Also, the use of Quarry Dust as the fine aggregate decreases the cost of concrete production in terms of the complete replacement for natural river sand. This paper reports the experimental study which investigated the influence of 100% replacement of sand with quarry dust.

Currently India has taken a major initiative on developing the infrastructures such as express highways, power projects and industrial structures etc., to meet the requirements of globalization, in the construction of buildings and other structures concrete plays the rightful role and a large quantum of concrete is being utilized. River sand, which is one of the constituents used in the production of conventional concrete, has become highly expensive and also scarce. In the backdrop of such a bleak atmosphere, there is large demand for alternative materials from industrial waste.

The utilization of Quarry Rock Dust which can be called as manufactured sand has been accepted as a building material in the industrially advanced countries of the west for the past three decades .As a result of sustained research and developmental works undertaken with respect to increasing application of this industrial waste, the level of utilization of Quarry Rock Dust in the industrialized nations like Australia, France, Germany and UK has been reached more than 60% of its total production. The use of manufactured sand in India has not been much, when compared to some advanced countries.

This paper presents the feasibility of the usage of Quarry Rock Dust as hundred percent substitutes for Conventional Concrete. Tests were conducted on cubes and beams to study the compressive, flexural strengths of concrete made of Quarry Rock Dust for three different proportions and five different methods. Durability Studies were done for concrete with Quarry Rock Dust and compared with the Conventional Concrete.

TABLE.1. Physical Properties Of Pond Ash

Properties	Pond Ash
Physical Properties	
Color	Whitish grey
Specific Gravity	2.153
W. Absorption in 24 hours	44.50%

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TABLE.2. Sieve Analysis

IS sieve size	Weight retained gm	Cumulative weight retained gm	Cumulative percentage weight retained	Cumulative percentage passing
40	0	0	0	100
20	0	0	0	100
10	10	10	2	98
4.75	40	50	10	90
2.36	30	80	16	84
1.18	105	185	37	63
600mic	160	345	69	31
300mic	100	445	89	11
150	10	455	91	9
Residue	45	500	_	_
Total	500		314	_

Fineness Modulus FM = 314/100= 3.14 (ii) Bulk density= 1.01g/cc (iii) Specific gravity 2

TABLE.3. Chemical Properties Pond Ash

Si. No	Compounds	% composition
1	Silicon dioxide (SiO2) plus, Aluminum oxide (A12O3) Plus, Iron Oxide (Fe 2O3) percent by mass	79.97
2	Silicon dioxide (SiO2) percent by mass	36.22
3	Magnesium oxide (Mgo) percent by mass	2.73
4	Total sulphur as sulphur Tri oxide (SO3) percent by mass	0.69
5	Available alkalis as sodium oxide (Na203) percent by mass	2.12
6	Loss on ignition percent by mass	6.84
7	Moisture content percent by mass	1.78

Sieve Analysis For Quarry Dust(Grading)

(Conforming zone from IS383-1970)

By passing the sample downward through a series of standard sieves, each of decreasing size openings, the aggregates are separated into several groups, each of which contains aggregates in a particular size range.

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Residue	45	500	_	_
Total	500		314	_

Mix Proportion For M_{20} Grade Concrete

TABLE.4.The Mix Proportion

Water	Cement	Fine aggregate	Coarse aggregate
191.58	399.125	561.815	1185.394
0.48	1	1.408	2.969

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TABLE.5.Cement 30% Replaced By Pond Ash and Sand 100% replaced by Quarry Dust

Water	Cement	Pond ash	Fine aggregate	Coarse aggregate
191.58	279.38	119.737	561.815	1185.394
0.48	0.7	0.3	1.408	2.969

TABLE.6.Cement 35% Replaced By Pond Ash and Sand 100% Replaced By Quarry Dust

Water	Cement	Pond ash	Fine aggregate	Coarse aggregate
191.58	259.43	139.69	561.815	1185.394
0.48	0.65	0.35	1.408	2.969

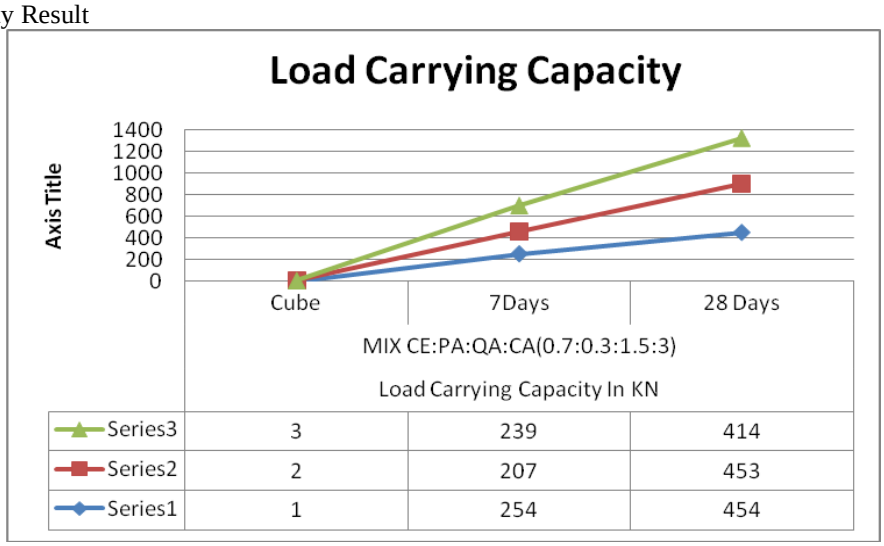
TABLE.7. Cement 40% Replaced By Pond Ash And Sand 100% replaced by Quarry Dust

Water	Cement	Pond ash	Fine aggregate	Coarse aggregate
191.58	239.47	159.65	561.815	1185.394
0.48	0.6	0.4	1.408	2.969

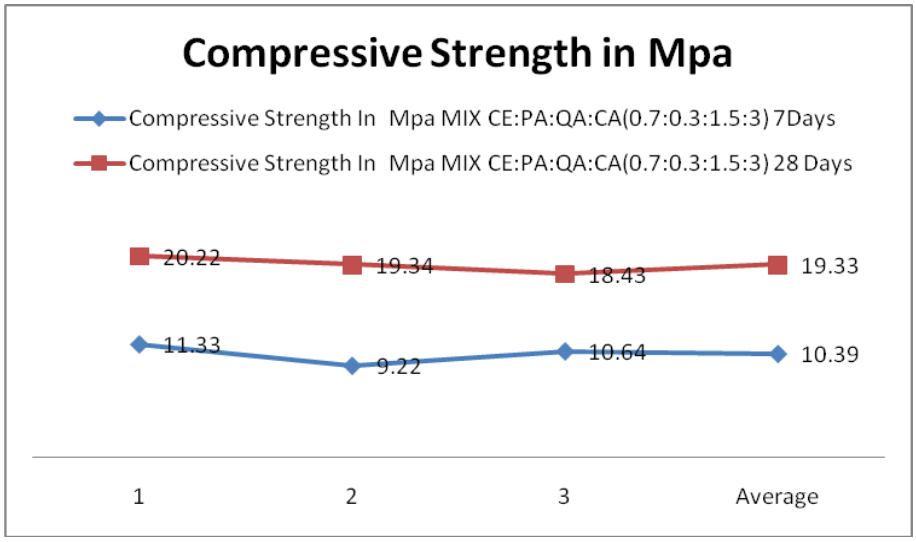
2. Test Results

Cement 30% Replaced By Pond Ash and Sand 100% Replaced By Quarry Dust

Load Carrying Capacity Result



Compressive Strength Result



Cement 35% Replaced by Pond Ash and Sand 100% replaced by Quarry Dust

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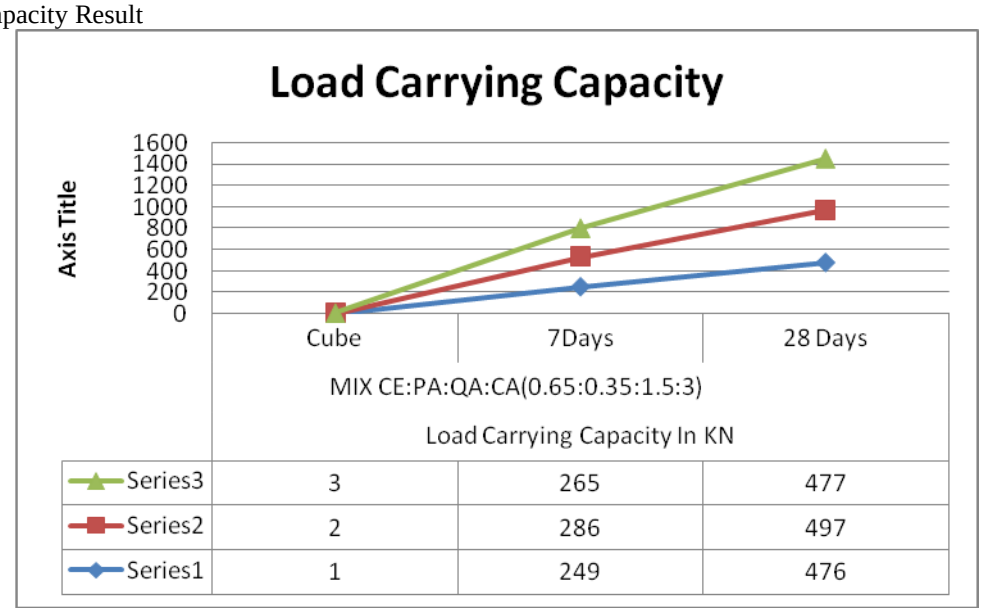
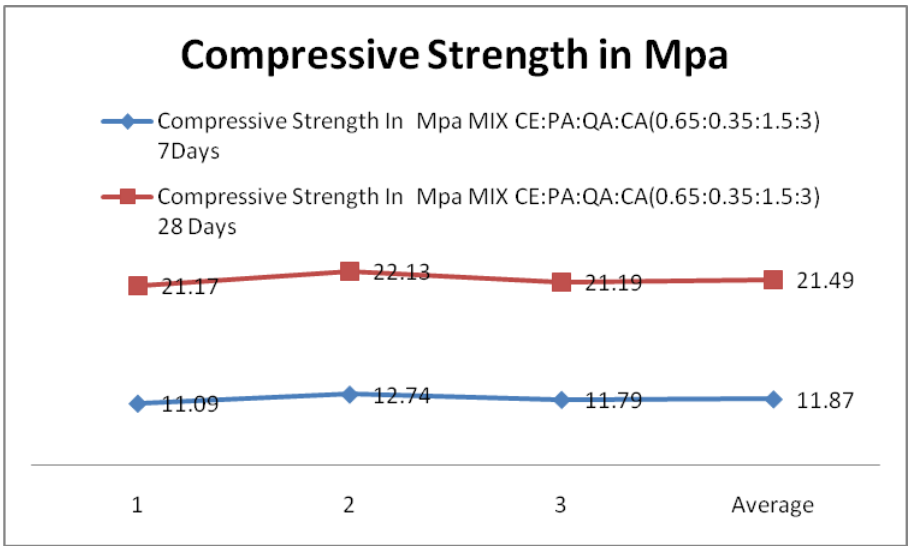
Load Carrying Capacity Result



Compressive strength Result



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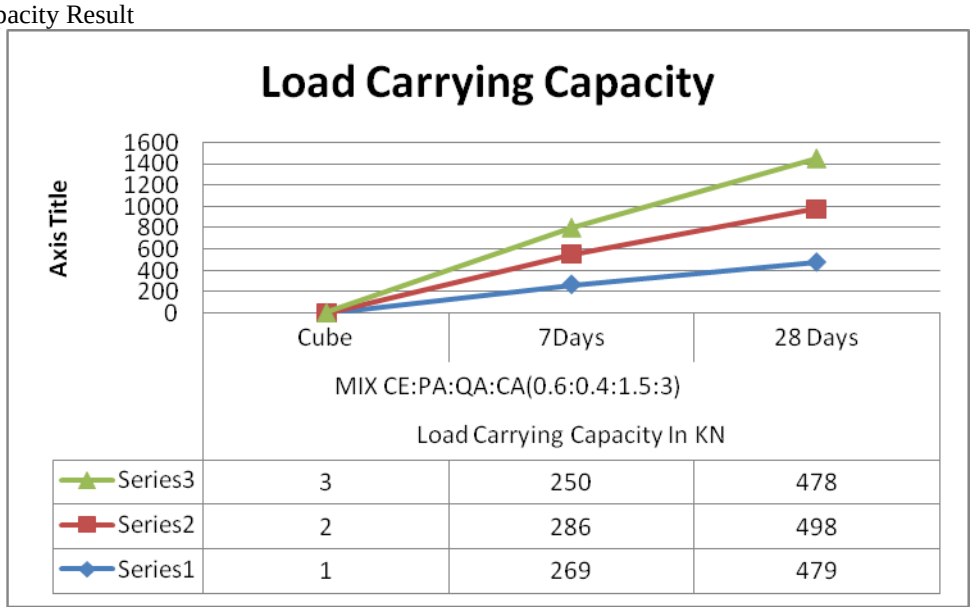
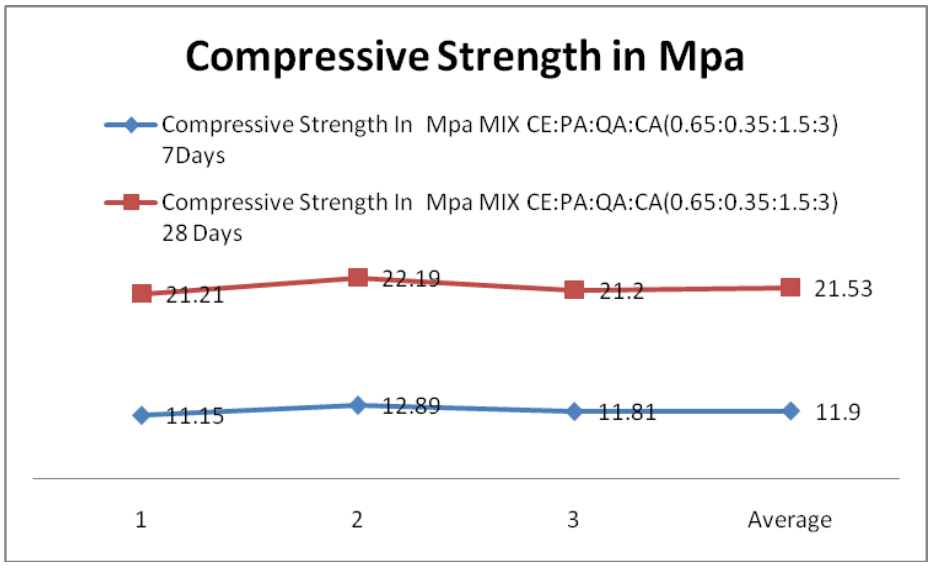
Load Carrying Capacity Result



Compressive strength Result



4. CONCLUSION

The analysis of experimental data showed the reaction of quarry gust with pond ash in concrete improved the strength.

- The disposal of Pond Ash should be maintained properly due to its unpozzolonic property.
- In this the effective use of Pond Ash can reduce the hazardness to the environment. At the same the economical utilization of Pond Ash and Quarry Dust should be followed.

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